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DEVELOPMENT OF GROUND-WATER SUPPLIES ON THE PAJARITO PLATEAU, LOS ALAMOS COUNTY, NEW MEXICO

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Abstract.—The Pajarito Mesa well field, completed in 1966 on the Pajarito Plateau, contributed 37 percent of the total water supply to Los Alamos in 1967. Two wells in the field are capable of yields of 1,400 gallons per minute each. This yield is about three times that of any of the other 13 supply wells in the water-supply system. The high yield of the two wells is attributed to the occurrence of coarse volcanic debris and arkosic sediment in the Puye and Tesuque Formations of the Santa Fe Group that make up the main aquifer beneath the Pajarito Plateau.

The town of Los Alamos and laboratories of the U.S. Atomic Energy Commission and the Los Alamos Scientific Laboratory are located on the Pajarito Plateau in north-central New Mexico (fig. 1). Since the community was established in 1943 the demand for water, created by population growth and the expansion of the laboratories, has equaled and at times exceeded the amount of water that had been developed.

The initial water supply was obtained from small streams and springs in the mountains west of the town. These sources soon became inadequate, and in 1949 a ground-water supply was established. Since conversion of the water-supply system to ground-water sources, the U.S. Geological Survey has assisted the U.S. Atomic Energy Commission in the development and management of the ground-water supply.

HYDROGEOLOGIC CONDITIONS OF THE PAJARITO PLATEAU

The Pajarito Plateau forms a topographically high area that slopes gently eastward from the flanks of the Sierra de los Valles toward the Rio Grande (Kelley, 1952, p. 93). The plateau is formed by rocks of the Santa Fe Group of middle (?) Miocene to Pleistocene(?) age, and volcanic rocks of Pliocene and Pleistocene age (Griggs, 1964, fig. 8). Figure 2 is a diagrammatic section showing the geologic units in the Los Alamos area.

The Santa Fe Group comprises the Tesuque and the Puye Formations, and the basaltic rocks of Chino Mesa. These formations crop out along the eastern margin of the Pajarito Plateau. The permeable sediments of the Tesuque Formation are the main aquifer penetrated by the wells in Los Alamos and Guaje Canyons.

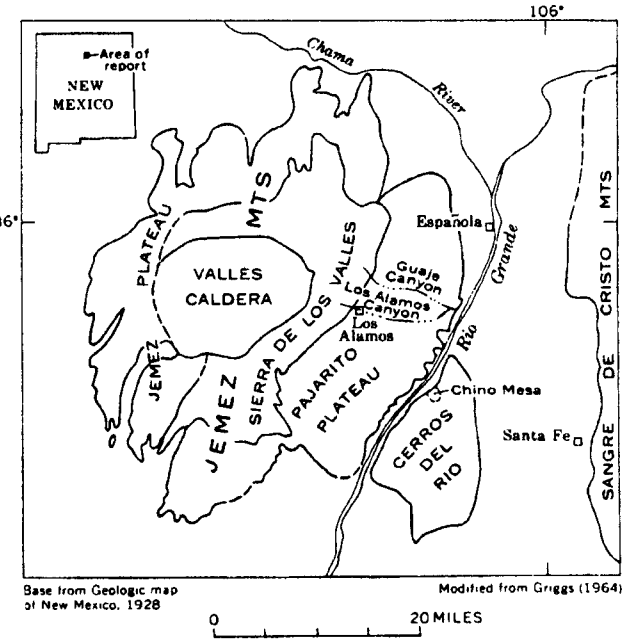

FIGURE 1.—Map of the Los Alamos area, showing topographic features mentioned in the text.

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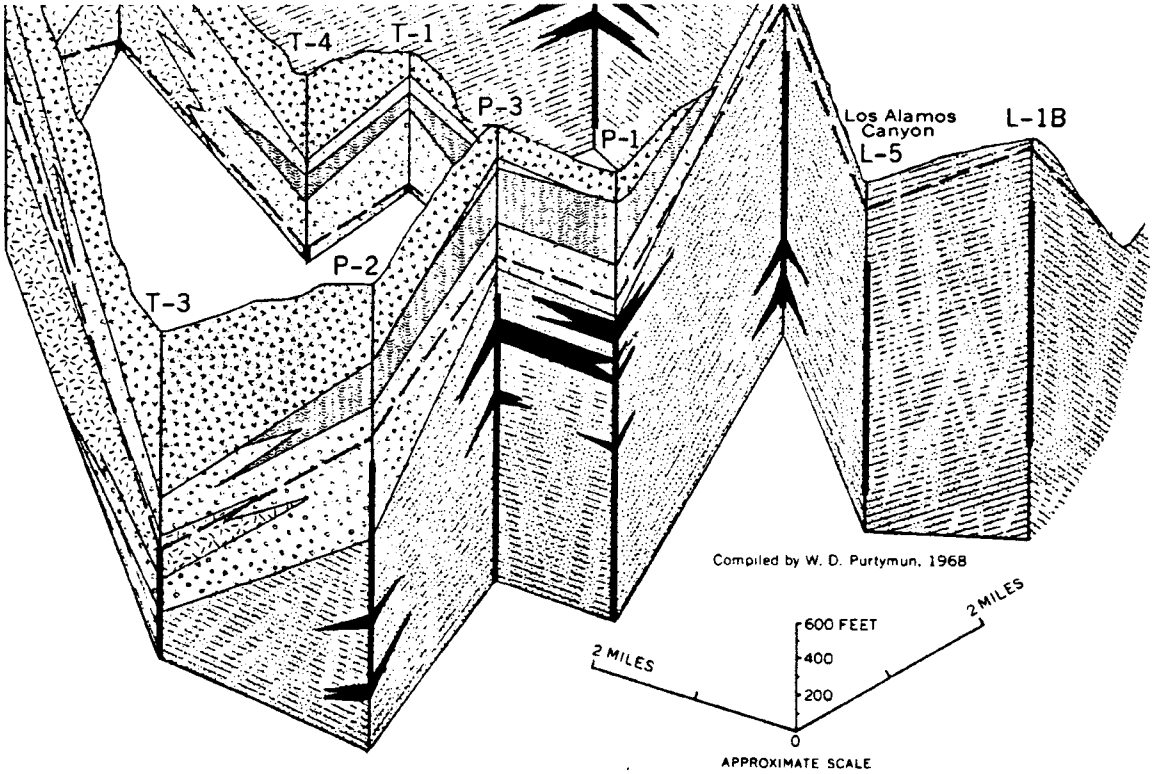


EXPLANATION

Bandelier Tuff

Puye Formation

Basaltic rocks of Chino Mesa

Tschicoma Formation

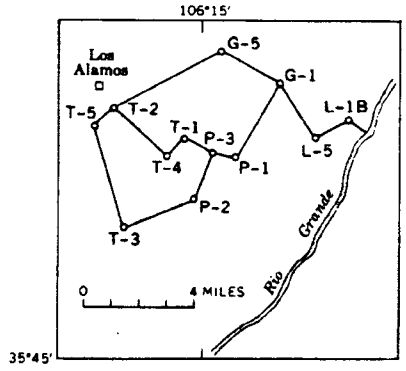
Tesuque Formation

Basalt in the Tesuque Formation

Well

Heavy line shows section that is all or partly open to the aquifer

Top of main aquifer



LOCATION OF WELLS AND LINES OF SECTION

FIGURE 2.—Diagrammatic section of geologic units in the Los Alamos area.

The Tesuque Formation consists of friable to moderately well cemented light-pinkish-gray to light-brown siltstone and sandstone that contains lenses of conglomerate and clay and some interbedded basalt flows. The sedimentary rocks were derived from two sources. The lower part of the formation penetrated by wells in Los Alamos and Guaje Canyons consists principally of fine arkosic quartz sand derived from source areas to the east of the Rio Grande. The upper part consists of very coarse arkosic quartz sand, latitic gravels, and volcanic detritus, derived from sources both east and west of the Rio Grande (Griggs, 1964, p. 22).

The Puye Formation is a poorly consolidated conglomerate channel-fill deposit overlain by a fanglomerate composed of volcanic debris. The channel-fill deposits are gray and consist of fragments of quartzite, schist, gneiss, and granite, ranging in size from sand to boulders. The fanglomerate is generally gray and consists of pebbles and cobbles of rhyolite, latite, quartz-latite, and pumice, in a matrix of silt and sand. Sorting is poor, but tongues and lenses of fairly well sorted pumiceous siltstone and water-laid pumice are present within the fanglomerate. The rocks were derived from flows associated with the volcanic rocks of Jemez Mountains.

The basaltic rocks of Chino Mesa consist of basalt and basalt breccia that overlie the Puye along the Rio Grande and interfinger with the conglomerate to the west beneath the Pajarito Plateau (fig. 2). The basalt, which thickens southward along the river and thins westward, originated from volcanic vents near Chino Mesa (fig. 1).

The volcanic rocks consist of the Tschicoma Formation of Pliocene age and the Bandelier Tuff of Pleistocene age. The Tschicoma Formation forms the mountains of the Sierra de los Valles, and is present in the subsurface beneath the western edge of the plateau (fig. 2). The deposits are composed of latite, quartz-latite flows, and pyroclastic rocks. The Tschicoma Formation is overlain by the Bandelier Tuff along the flanks of the mountains. The Bandelier Tuff, a series of ash flows and ash falls of rhyolitic tuff, caps the Pajarito Plateau and unconformably overlies the Puye Formation and basaltic rocks of Chino Mesa in the central and eastern parts of the plateau. The Tschicoma Formation, the Bandelier Tuff, and the basaltic rocks of Chino Mesa contain only small amounts of water, which usually is perched above a confining layer.

DEVELOPMENT OF GROUND-WATER SUPPLIES

The first water-supply wells drilled in the Las Alamos area were located along the eastern edge of the Pajarito Plateau in Los Alamos Canyon and Guaje Canyon, which are tributary to the Rio Grande (fig. 1). The wells were located in the canyons rather than in the higher elevations of the Pajarito Plateau in order to keep drilling depths to a minimum and to be as close as possible to the then-known aquifers in the Santa Fe Group. The wells yielded satisfactory quantities of water, 500 gallons per minute or more, and several of them have been in continuous service for 20 years or more. In 1967, six wells located in Los Alamos Canyon and seven wells located in Guaje Canyon supplied 63 percent of the total amount of water (1.3 billion gallons) used by Los Alamos (table 1).

In 1963, because of increasing water demands and lack of additional space for new wells in Los Alamos and Guaje Canyons, new locations were sought on the Pajarito Plateau. Test drilling on the plateau indicated that the main aquifer, entirely within the Tesuque Formation in the lower part of Los Alamos and Guaje Canyons, rises stratigraphically westward, and that beneath the central part of the plateau the lower part of the overlying Puye Formation is saturated and becomes a part of the aquifer.

These data, as well as extensive knowledge of the surface geology, suggested that the saturated portion of the Puye Formation and the sediments in the upper part of the Tesuque Formation would yield considerable quantities of water to a well that penetrated deeply into the zone of saturation. Even though wells on the plateau might need to be as much as a thousand

TABLE 1.—*Pumping rate, total pumpage, and specific capacities of wells in Los Alamos Canyon, Guaje Canyon, and Pajarito Mesa well fields, 1967*

Location	Number of wells	Pumping rate (gpm)			Total pumpage		Specific capacity (gpm per ft of drawdown)		
		Range		Average	Millions of gallons	Percent of total	Range		Average
		From	To				From	To	
Los Alamos Canyon	6	360	565	495	373	28	2	14	6
Guaje Canyon	7	395	560	425	465	35	2	13	6
Pajarito Mesa	[1] 2	635	1,425	1,030	481	37	15	26	20

[1] Does not include well P-3, which was added to the system in January 1968.

feet deeper than wells drilled at lower elevations in the canyons, the economic savings resulting from shorter pipelines and greater choice for well locations, made such drilling feasible.

The first deep well, P–1, of the Pajarito Mesa well field (well-field designation of the U.S. Atomic Energy Commission) was drilled in 1964 to a depth of 2,500 feet on the Pajarito Plateau. It penetrated about 1,800 feet of saturated sediments and volcanic rocks in the Puye and Tesuque Formations. The coefficient of transmissibility at the well and specific capacity of the well are greater than that of wells in the Los Alamos and Guaje Canyons (table 2).

Data from well P–1 enabled further interpretation of the geology and hydrology beneath the plateau, and sites for additional wells were established to the west, at even higher elevations on the plateau. In 1965 a second well (P–2) was completed at a depth of 2,300 feet, and in 1966 a third well (P–3) was completed at a depth of 2,550 feet. These wells were constructed to accommodate pumps capable of producing 1,400 gpm each. The specific capacity of these wells on the plateau is four to six times greater than that of the Los Alamos and Guaje Canyons wells (table 2).

QUALITY OF WATER

The chemical quality of water may vary within a well field owing to local conditions that exist in the aquifer in the vicinity of the well. In general the water from the supply wells is of good quality for domestic use (table 3), as it contains less than 500 parts per million of dissolved solids (U.S. Public Health Service, 1962, p. 33). In the Pajarito Mesa well field the quality and temperature of water from wells P–1 and P–3 are similar, but water from well P–2 is somewhat different. The major yield to wells P–1 and P–3 is from the coarse sediments of the Tesuque Formation, whereas a large part of the yield to P–2 is from a thick saturated section of Puye Formation. The section of each well that is open to the aquifer, either throughout the indicated section or at intervals within it, is shown on figure 2.

The silica concentration of water from the three wells ranges from 74 to 82 ppm. The silica and calcium-magnesium concentrations, particularly of P–1 and P–3, may require special treatment for some industrial uses inasmuch as these constituents will contribute scale to tubing and pipes when heated.

PRESENT YIELDS AND RECOMMENDATIONS FOR FUTURE SUPPLIES

Pumpage of ground water at Los Alamos in 1967 was 1.3 billion gallons. Two wells on the Pajarito Plateau produced 37 percent of this total (table 1); the heavy pumpage appeared to cause little or no change in water levels in the wells.

Information obtained from the drilling of the three deep wells on the Pajarito Plateau shows that the upper 1,000 feet of the Tesuque Formation is composed of coarse volcanic debris and arkosic sand. These coarse sediments yield larger amounts of water to wells than do the fine sediments that predominate in the formation farther to the east along the Rio Grande.

The Puye Formation attains greatest thickness in a north-trending depositional basin beneath the central part of the plateau (fig. 2). Partial saturation of the permeable conglomerate in the central part of the plateau contributes to the higher yields of the wells.

The main aquifer is at a depth of about 1,200 feet along the western edge of the plateau, and the depth

TABLE 2.—*Aquifer characteristics of selected wells in the Los Alamos area*

Supply well or test well [1]	Date drilled	Depth (feet) [2]	Depth to water (feet)	Pumping rate (gpm)	Specific capacity (gpm per ft of drawdown)	Aquifer [3]	Coefficient of transmissibility (gpd per sq ft)
L–1B	1960	1,750	40	560	5	QTst	17,000
L–5	1948	1,750	170	485	4	do	
G–1	1950	2,000	265	450	5	do	12,000
G–5	1951	1,840	445	555	7	do	12,000
P–1	1964	2,500	740	640	15	QTsp, QTst	55,000
P–2	1965	2,300	835	1,425	26	do	40,000
P–3	1966	2,550	740	1,400	38	do	343,000
T–1	1949	815	750	6	.5	QTsp	7,700
T–2	1950	1,205	1,166	2	.6	QTt	1,000
[illegible]3	1960	1,821	1,173	88	6	QTsp, QTt, QTst	11,000
[illegible]4	1960	1,065	968	16	2	QTsp	2,400
[illegible]5	1949	2,000	970±5			QTsp, QTt	

[1] G, supply well in Guaje Canyon; L, supply well in Los Alamos Canyon; P, supply well on Pajarito Plateau; T, test well.
[2] Completed depth of well.
[3] QTsp, Puye Formation; QTst, Tesuque Formation; QTt, Tschicoma Formation.

TABLE 3.—*Chemical analyses of water from selected wells in Los Alamos Canyon, Guaje Canyon, and Pajarito Mesa well fields*

[Analyses by Group H-7 of the Los Alamos Scientific Laboratory]

Supply well [1]	Date Collected	Temperature (°F)	Chemical constituents (parts per million)											pH	Specific conductivity (micromhos at 25°C)
			Silica [2] (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Carbonate ($CaCO_3$)	Bicarbonate (HCO_3)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Total dissolved solids	Total hardness (as $CaCO_3$)		
L-1B	5-28-68	87	37	8	1	195	0	262	17	2	0.2	409	24	8.1	600
L-5	6-18-68	78	36	10	0	105	0	134	0	.9	.2	191	26	8.3	232
G-1	5-28-68	80	84	12	.5	38	0	74	3	.4	.3	199	32	8.0	152
G-5	5-25-68	78	60	18	3	23	0	74	3	.4	.4	163	56	7.8	158
P-1	6-18-68	83	82	28	5	36	0	122	5	.3	.1	246	90	7.9	248
P-2	6-18-68	73	81	13	2	21	0	58	0	.3	.3	176	40	7.6	114
P-3	6-18-68	81	74	26	8	33	0	122	7	.3	.1	259	98	7.8	260

[1] G, supply well in Guaje Canyon; L, supply well in Los Alamos Canyon; P, supply well on Pajarito Plateau.
[2] Silica analyses are from samples collected in May 1967. Later samples have not been analyzed for silica.

decreases eastward with the gentle slope of the land surface to a depth of about 600 feet along the eastern edge (fig. 2). The water in the aquifer moves eastward toward the Rio Grande, which is the principal area for ground-water discharge (Cushman, 1965, p. D33).

Locations of future wells should be chosen carefully so as to avoid the relatively impermeable rocks of the Tschicoma Formation and the thick sections of basaltic rocks of Chino Mesa. These rocks are hard and are difficult to drill. Holes drilled in basalt are likely to be crooked because, in drilling, the bit may be deflected by joints or cavities. If rotary methods are used, it may be difficult to maintain fluid circulation in the hole at places where open joints occur. Additional wells capable of yielding from 1,000 to 1,500 gpm of water could be located at various sites near the center of the Pajarito Plateau.

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