discontinuous or sporadic occurrence of Cretaceous rocks. The thicknesses reported range from about 5 feet to a little more than 100 feet. The average thickness in the large areas near Lovington and Hobbs is between 20 and 60 feet. Most of these areas contain shotholes for which the drillers did not note the diagnostic colors and rock types. However, this may reflect only the wide range in accuracy and quality of the drillers' logs. Cretaceous rocks may actually be somewhat more widespread in the subsurface than shown on figure 338.1, judging by the logs of isolated wells and shotholes, but the data are too scarce to outline additional areas.

In the southernmost subsurface outlier as shown on figure 338.1 and in a few wells 2 to 5 miles north of Hobbs, drillers have reported 5 to 20 feet of hard limestone or "hard gray rock", which might be the equivalent of the limestone exposed east of Eunice.

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339. DISTRIBUTION OF MOISTURE IN SOIL AND NEAR-SURFACE TUFF ON THE PAJARITO PLATEAU, LOS ALAMOS COUNTY, NEW MEXICO

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Work done in cooperation with the U.S. Atomic Energy Commission

The Pajarito Plateau adjoins the steep eastern flanks of the Sierra de los Valles in north-central New Mexico. It has been dissected by eastward-flowing streams into several fingerlike mesas. The plateau is underlain by pumice deposits, ash falls, and ash flows that were ejected from a large volcanic vent to the west. Ash flows that cap the plateau are welded rhyolite tuff. Soil on the middle part of the mesas is well developed on the flat uplands and is thought to be derived largely from tuff weathered in place. Three zones are recognizable: An A zone from which most of the clay has been leached, a B zone containing montmorillonite, and a C zone (transitional from soil to tuff) with a high clay content. The zone of saturation is more than 1,000 feet beneath the surface of the plateau in the areas studied (fig. 339.1).

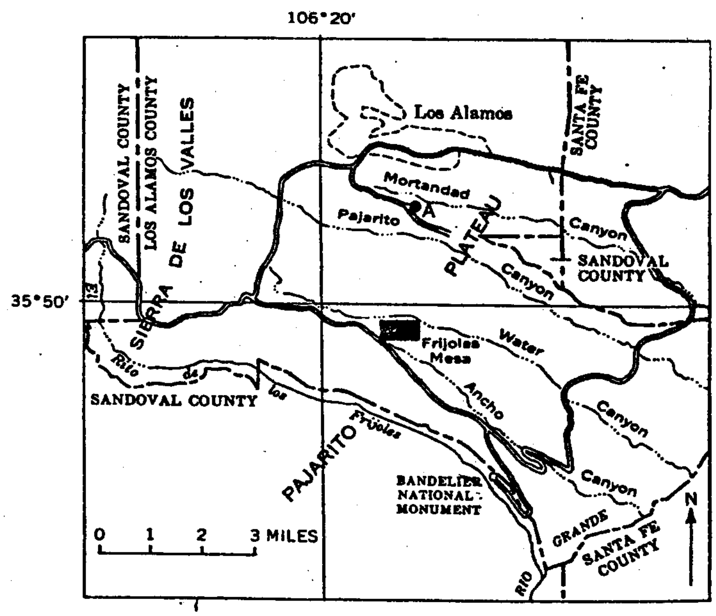

FIGURE 339.1.—Pajarito Plateau, N. Mex., showing area of moisture studies (shaded).

Measurements of the rate and amount of water movement and of moisture content of the soil and tuff, both under natural conditions and in controlled infiltration experiments, were made as an essential part of studies eous movements of radioactive substances origin- from liquid wastes or from leachable radioactive

These measurements were made as a part of the am with the Los Alamos Scientific Laboratory.
neutron-scattering moisture probe was inserted est holes cased with 2-inch plastic pipe to deter- the moisture content of the rock and soil. The rements were checked against laboratory deter- ions of moisture drill in cores. The moisture con- determined with the probe appeared to be about percent higher than those made in the laboratory.

NATURAL DISTRIBUTION OF MOISTURE

enty-three test holes were drilled on Frijoles Mesa noisture measurements were made in the spring, er, and fall of 1960 to study natural infiltration soil and tuff. In general, the moisture content ound to increase from the surface to a depth of 3 feet, then decrease to a depth of 4 to 12 feet, remain relatively constant at greater depths. were some variations, however, that were ap- tly related to drainage and soil thickness. Data the 23 test holes are summarized in the adjacent

	Thickness of soil (feet)		Depth at which moisture content was less than 10 percent (feet)		Depth at which moisture content was less than 5 percent (feet)	
	Range	Average	Range	Average	Range	Average
Fifteen test holes in well-drained areas	0.5–4.0	3.5	2.5–9.0	4.7	7.0–14.0	8.8
Eight test holes near arroyos, ditches, and in poorly drained areas	2.2–9.0	5.3	4.0–19.0+	9.5	(1)	

[1] Moisture content does not decrease to 5 percent; the holes range in depth from 19 to 49 feet.

The moisture content in the upper 5 or 6 feet was highest in March and April, as a result of late winter snow; it decreased to a minimum in October, owing to the high evapotranspiration rate during the summer and early fall.

Test-hole 5M–2 (fig. 339.2) is representative of the test holes in well-drained areas. Moisture measurements show that below a depth of 6 feet the moisture

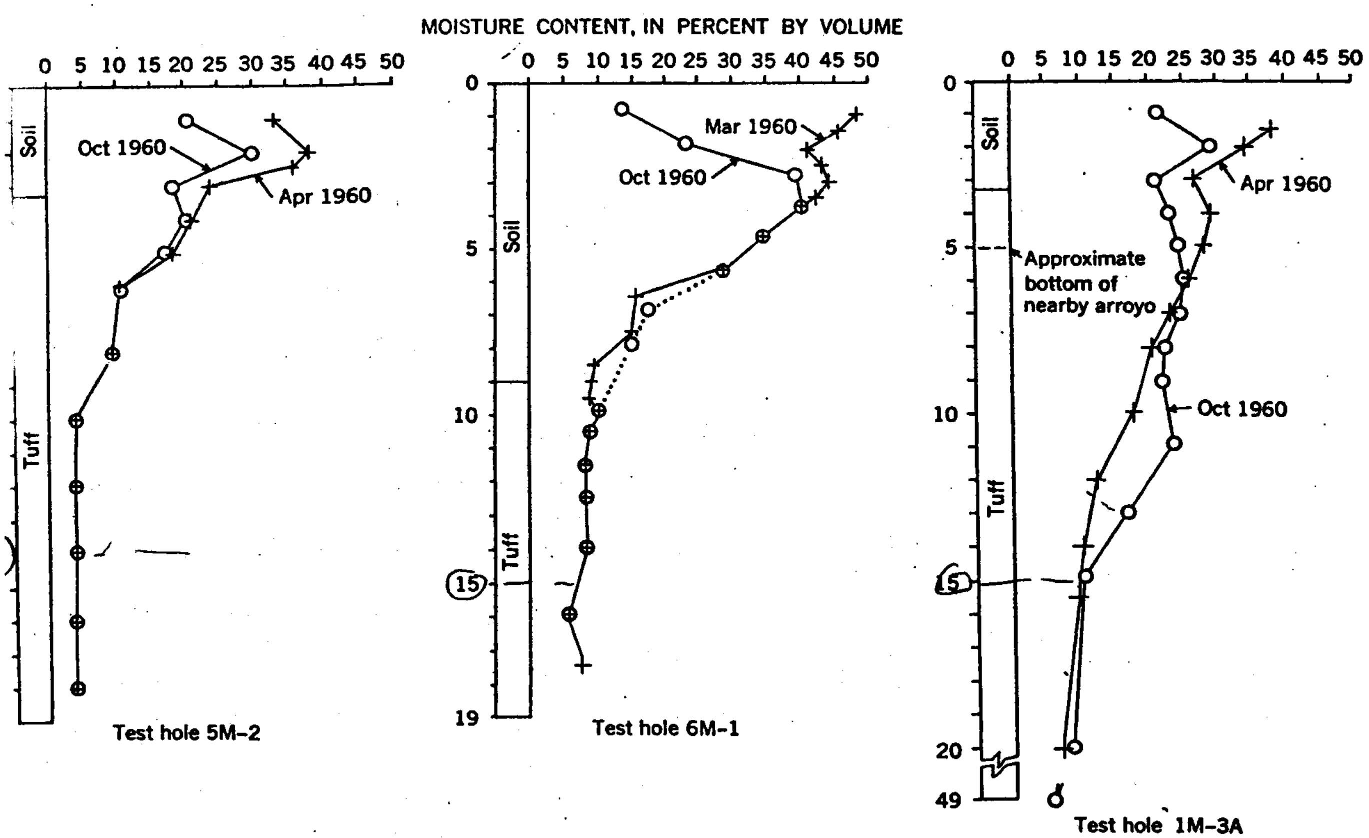

FIGURE 339.2.—Moisture measurements in selected test-holes on Frijoles Mesa, Los Alamos County, N. Mex.

content of the tuff remained unchanged and below 10 feet it was less than 4 percent.

Test holes near arroyos, ditches, and in poorly drained areas that received or retained water during periods of storm runoff are represented by test-holes 6M-1 and 1M-3A (fig. 339.2). Although moisture measurements in test-hole 6M-1 suggest a small increase in moisture content between about 6 and 10 feet in depth between March and October, they merely reflect the fact that measurements in this interval were made at slightly different depths. Thus, additional points on the October curve probably would have resulted in a curve that more nearly duplicated the March curve. In hole 6M-1 the moisture content below a depth of about 4 feet remained nearly the same, and the moisture content in the tuff ranged from 6 to 10 percent during both periods.

Construction near test-hole 1M-3A, on the bank of an arroyo, caused water to pond 2 to 4 inches deep several feet from the test-hole during wet periods. The ponded water percolated through the thin soil and sand in the bed of the arroyo and moved downward and laterally into the tuff as shown by the increase of moisture from 12 percent to 17 percent at a depth of

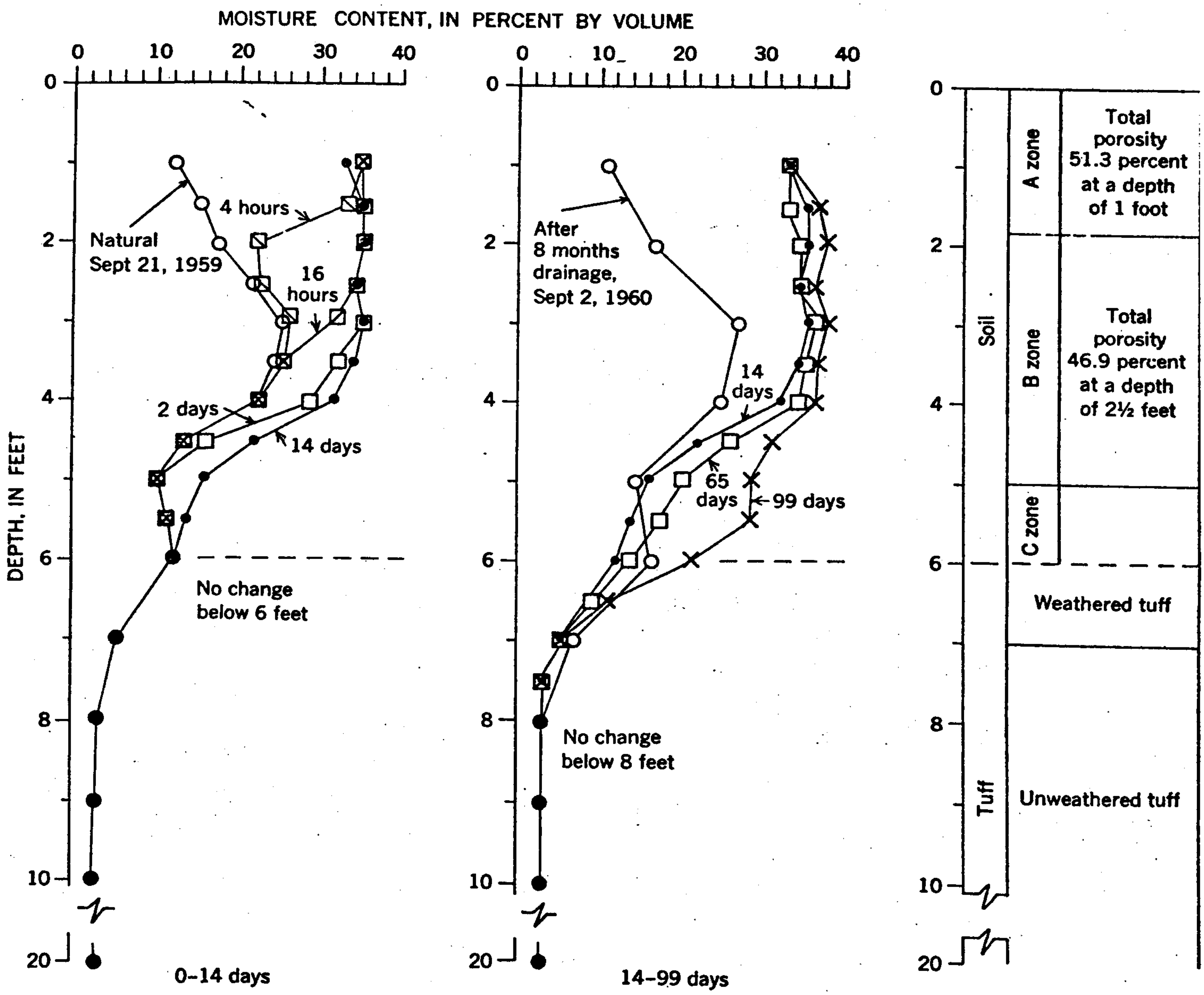

FIGURE 339.3.—Changes in moisture content beneath the infiltration pit at site A during 99 days of continuous infiltration, September 21 through December 29, 1959, and subsequent drainage for 8 months, Los Alamos County, N. Mex. Estimated rates of infiltration: 2nd day, 24 gallons per day per square foot; 10th day, 10 gpd per ft²; 20th day, 6 gpd per ft².

13 feet (fig. 339.2). Between 13 and 20 feet a l increase in moisture content is suggested, but een 20 and 49 feet the moisture content remained t 6 to 8 percent.

INFILTRATION EXPERIMENT

site *A* (fig. 339.1) an infiltration pit 2 feet in ıeter by 1 foot deep was constructed during Sepıer 1956. The soil is similar to that on Frijoles ı; it is about 6 feet thick and is underlain by 'ed tuff. The area is moderately well drained. A hole 20 feet deep was drilled in the center of the :ration pit and a 2-inch plastic pipe was installed ıat it projected about 1 foot above the pit. Soil tuff were packed around the casing to prevent age down alongside the casing. Moisture measurets were made prior to application of water. Water introduced into the pit and a constant head mained at three-quarters of a foot for 99 days.

he wetted front (fig. 339.3) moved to a depth of ıt 4½ feet during the first 2 days of infiltration and depth of about 6½ feet during the next 97 days, water did not move through the transition zone the tuff, except in the lower moisture range. The sture content decreased with depth from a maxiı of about 38 percent in the B zone of the soil to than 4 percent within a foot of the surface of the

'ater apparently was perched on the C zone of the and the moisture content within the B zone approached saturation. After the first several days of infiltration, most movement of water probably was lateral, as indicated by measurements in a series of holes around another infiltration pit nearby. Some water undoubtedly was lost by evaporation and transpiration.

Although the quantity of water used during the study was equivalent to almost 50 years of precipitation on the Pajarito Plateau, the moisture content in the A and B zones had returned to nearly normal after 8 months of drainage; the moisture content in the C zone and top 2 feet of tuff was slightly higher than before the experiment, and the moisture content of the tuff between 8 and 20 feet was unchanged. However, conditions during this study cannot be considered normal because the clogging or silting of pores probably was greatly accelerated when this volume of water moved into the soil within a period of 99 days without the normal seasonal distribution which involves alternate percolation and drainage.

CONCLUSIONS

Although water not removed by surface drainage infiltrates into the soil of the Pajarito Plateau, this study indicates that the downward movement of this water is impeded or stopped by the dense transition zone between the soil and the tuff. Thus, it seems that where the normal soil cover is undisturbed, there would be little or no recharge to the zone of saturation from precipitation on the surface of the plateau.

STRUCTURAL EVOLUTION OF THE VALLES CALDERA, NEW MEXICO, AND ITS BEARING ON THE EMPLACEMENT OF RING DIKES

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'he Valles caldera is located 50 miles northwest of ıta Fe, N. Mex., in the heart of the Jemez Mountains, road uplift composed of late Tertiary and Quatery volcanic rocks that rest on igneous, metamorphic, sedimentary rocks of Precambrian through Ter'y age. The volcanic rocks are of the alkali-calcic :e and range in composition from basalt, through lesite, dacite, rhyodacite, and quartz latite, to rhyo. They cover an area of over 1,000 square miles and ıin a maximum thicknes of at least 5,000 feet. Strucally, the volcanic rocks are situated on the western rgin of the Rio Grande depression and are faulted progressively downward to the east by numerous northtrending faults.

In early Pleistocene time, after a period of quiescence and erosion, a series of catastrophic eruptions broke out in the center of the volcanic pile, and nearly 50 cubic miles of rhyolitic pyroclastic material in the form of ash flows poured, from vents now concealed, down canyons in the higher mountains and spread out as broad coalesced fans on the surrounding gentler slopes. The resulting deposits, now recognizable as sheets of welded tuff, attain a maximum thickness of 1,000 feet and constitute the larger part of the Bandelier rhyolite tuff